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October 20, 2005

Draft Questions Pertaining to Flow Profile Considerations for Plant UFM Uncertainty Applications

*UFM review may by the critical path for review of power uprate applications that credit an improvement of determination of feedwater flow rate due to installation of UFMs. The following questions are intended to address potential issues pertaining to interaction of the UFM with water flowing in feedwater pipes and specifically to flow profile considerations that should be addressed in licensee applications for a change in thermal power level that credits improved performance attributed to the UFM. The intent of this draft is to provide a "road map" that identifies typical topics the staff plans to address in its review - the questions should not be treated as formal RAIs where a response is requested. Where the topics have been satisfactorily addressed prior to provision of RAIs, then obviously such RAIs would be unnecessary and this could contribute to a reduction in review time.*

Please provide a complete description of the work accomplished to directly support the use of the UFM in your plant. Include the following:

1. Laboratory testing
   - 1.1 Completely describe the laboratory test configurations
   - 1.2 Describe the analyses conducted to support the laboratory tests
   - 1.3 Summarize the data obtained from each laboratory test that compares the UFM indication with the laboratory test facility flow rate result and provides the correction factor necessary for the UFM to agree with the laboratory test result
     - 1.3.1 Provide the date and time for each laboratory test
     - 1.3.2 Identify any laboratory tests excluded from the results and provide the reason for exclusion.
   - 1.4 If hydraulic noise is a potential issue for your UFM, then summarize the results of noise evaluations. Include the effect of temperature change. Address whether the effect of noise contamination is a function of location within a plane perpendicular to the pipe. If noise is not a concern, then provide a justification for the conclusion.
   - 1.5 Describe the evaluations supporting application of flow laboratory test results to your plant. Include:
     - 1.5.1 Flow profile evaluations including the effect of swirl.
     - 1.5.2 Evaluation of potential differences in flow profile between the flow laboratory tests and your assumed plant installation flow profile for any items that are not addressed in Question 2.6, below.
   - 1.6 Summarize how the data analysis was performed.
     - 1.6.1 Provide the uncertainty analysis for the aggregation of the data.
     - 1.6.2 Provide the uncertainty analysis for relating the data to your plant installation (see question 1.5 above).
     - 1.6.3 Address the uncertainty analysis associated with tracing laboratory testing and plant installation back to NIST standards
2. Plant installation
   - 2.1 Discuss the flow rate specification for the UFM. For example, is the UFM rated as percent of flow rate or as of full scale?
   - 2.2 If flow straighteners were used in any of the testing or are used in the plant

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installation, then describe any benefits or adverse impacts that flow straighteners may have on the UFM flow indication.

2.3 Completely describe the feedwater pipe from the feedwater pumps to the steam generators.

2.3.1 Include layout drawings and P&IDs.

2.3.2 Identify and describe all hardware that may cause a perturbation of the flow profile. This is to include, but is not limited to, elbows, tees (including instrument tubing connections), valves, changes in pipe diameter, flow straighteners, venturis, heat exchangers, welds, orifices, resistance temperature devices (RTDs), thermocouples, and changes in pipe roughness (if any).

2.3.3 Identify any paths that may provide flow bypass of the UFM and, if such paths exist, address how potential bypass flow will be addressed.

2.3.4 Include the location of the UFM instrumentation.

2.4 Describe the process and rationale for selection of the permanent UFM installation location(s).

2.5 Describe each pre-operational plant test configuration including the UFM location and orientation, valve configurations, pump configurations, all flow rate indications, all temperature indications, and all plant characteristics that may provide information to assess UFM performance. A representative set of data are to be completely described for one plant test and the remaining plant test results are to be described in terms of configuration identification and average values for each flow rate and temperature.

2.6 Provide a comparison and evaluation of the laboratory test configuration(s) to your plant installation for each plant configuration for which the vendor has certified that the UFM meets all application criteria. Include:

2.6.1 Assessment of changes in flow profile between the laboratory test configuration and the plant installation.

2.6.2 A description of the UFM design features, testing, and operational controls that ensure that changes in flow profile and flow rates that may differ between those assumed during laboratory flow tests and those assumed during the UFM commissioning at your plant are identified and accounted for during the UFM commissioning.

2.6.3 A description of supporting evaluations. Include a discussion of the methodologies used (flow laboratory modeling, computational fluid dynamics, insitu testing, or other confirmatory testing) to confirm that a plant specific UFM installation is adequately represented by an associated flow laboratory configuration. Discuss the impact the various methodologies may have on plant specific UFM uncertainties or biases.

2.6.4 Include discussion of the contribution to flow uncertainty and bias due to changes in flow profile that were taken for the UFM in moving from the laboratory test configuration(s) to the plant specific configuration(s).

2.6.5 If noise is an issue, then address how noise in the fluid or pipe is treated. Include how noise is treated with respect to error indication and allowance for error due to noise. Include design features and plant testing available to identify and correct its effects during commissioning and subsequent operation. If noise is not a concern, then provide justification for this conclusion. (See Item 1.4, above.)

2.6.6 Address the effect of pipe roughness changes between the laboratory and plant installations.

2.6.7 Provide evaluation results.

2.7 Discuss differences in flow laboratory tests and plant commissioning tests with regard to the duration of data collection and impact on flow indication and uncertainty.

2.8 Describe the evaluations / validations performed to establish the UFM operational characteristics such as, but not limited to, the effect of perturbations in plant operation, in-situ calibrations, and to establish the UFM operational limits.

2.9 Provide a copy of the vendor's validation report and a copy of the vendor certification(s) regarding the UFM installation in your plant.

3. UFM operation

3.1 Completely describe the methodology by which the UFM performs an error analysis involving changes in flow profile and how it provides an assessment of error. Include the following:

3.1.1 How the UFM recognizes changes in flow profile and how such changes are translated into an error indication and into error reporting. Include discussion of the variance in measurements associated with determining average velocity and your estimate of the variance in average velocity determinations.

3.1.2 A description of the UFM design features, in-plant testing, and operational controls that identify changes in flow profile and flow rates from that assumed during commissioning and during operation. Discuss the associated contribution to flow uncertainty taken for the UFM during plant operation. Discuss how, in the case of an abnormal reading, you distinguish a change in flow from a change in performance of the UFM and provide the background information to support this process. Further, if you find the fault is with the UFM, discuss how you perform a recalibration.

3.1.3 Operational limits including control of the plant configuration with respect to the UFM operation.

3.1.4 A complete assessment of the effect of operation at the operational limits of the error band on uncertainty and bias. Include the total uncertainty and bias for the upper and lower operational limits and for the nominal operation condition between the limits and show how the uncertainty and bias associated with off-nominal operation are incorporated into the overall instrument uncertainty and bias.

3.1.5 If the UFM installation provides the capability for cross checking (such as UFM instrumentation in series), then describe the cross checking process. Include a discussion on measurement independence, random uncertainty, and biases with this arrangement. Also discuss procedures to be implemented should the cross checking capability become inoperable including operation with the associated power uprate.

3.1.6 If feedwater flow is from a common header and individual feedwater line temperatures differ from each other or from the common header temperature, then describe the cause of the effect, the potential effect on the UFM indication, instrument uncertainty, and the actions taken to address that effect.

3.2 Provide a copy of the control room procedures that address operator interactions with the UFM indication.

3.3 Describe personnel training for UFM maintenance and operation.

3.4 Describe operational experience with the UFM at your plant.

3.5 Describe any time dependent plant conditions that might effect the UFM performance (fouling, de-fouling, changes in water chemistry, etc.).

3.6 Provide available comparisons of the UFM - indicated flow rate with other parameters that provide independent assessments of UFM flow rate or changes in flow rate. Include an uncertainty assessment for the comparison and its impact on UFM uncertainty and power uprate assumptions if this information is used to assess UFM operability, conformance to the plant commissioning performance assumptions, and power uprate status. Include how you process this information via parameter trending and provide trending information.

3.7 Describe your participation in the UFM Users Group.

3.8 Describe your process for responding to information obtained from the UFM Users Group and from experiences with the UFM in other nuclear power plants.

3.9 Assuming the License Amendment Request (LAR) was previously granted, identify and assess any instances where the UFM provided flow rate signals would have resulted in exceeding licensed thermal power limits. Describe how these instances were identified (independent means or the UFM diagnostic, etc) and describe changes to procedures, installation, design, or in-plant testing to prevent recurrence.

Where appropriate, your responses may be limited to a brief description plus including specific material from documents by reference. Such material shall be identified in a manner that excludes most extraneous material and such references shall be provided or available on the docket.